

able, can not be definitely determined from existing data. In any event, it is a phenomenon absent from the clearest skies and one which is rapidly masked by the presence of considerable thicknesses of cloud materials. Whatever be its nature, it indicates an occasional departure from the distribution of intensities which characterizes the perfect sky of Rayleigh, of a sort which demands further investigation.

It will be seen from the foregoing that there are between the typical curves for the unclouded sky as exhibited in fig. 3 and the curves for completely overcast sky (fig. 1), a number of intermediate forms of considerable complexity. The presence of condensed vapor has the effect of increasing the intensity of the longer wave-lengths of the spectrum so that the ordinates of the curves are raised thruout the red, yellow, and green. At the same time the maximum in the blue is developed and the spectrum of light from the sky shows the phenomenon of selective reflection to a remarkable degree. Light from sun-illuminated cloud masses exhibits the further modifications shown in curve *d* of fig. 4, in which the intensities in the red, yellow, and green reach their highest values. The maximum in the blue is in this case still noticeable, altho by no means so marked as in the case of light from a clear sky in the presence of incipient mist.

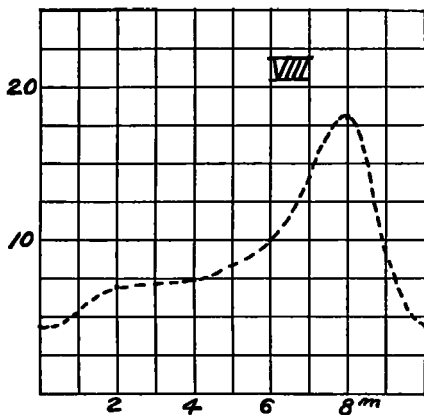


FIG. 8.

That the brightness of the sky increases with the gathering of cloud masses, up to the point where sunlight is completely shut out and the sky becomes thickly overcast, is clearly shown by means of the results graphically recorded in fig. 8. The readings from which this curve was plotted were all made from a single wave-length in the red end of the spectrum. The observations were taken during the rapid gathering of clouds upon a showery day, the initial condition being that of a blue sky with no visible mist. Measurements were made as rapidly as possible during the interval of ten minutes, at the end of which the sky was completely and heavily overcast. The curve which has time as abscissas counting from the first observation and intensities of the wave-lengths in question (0.7μ), in terms of that of the acetylene flame as ordinates, rises to a well-marked maximum after eight minutes and then falls to a value, after ten minutes, almost identical with the value of the initial reading. The maximum corresponded as nearly as could be observed to the sudden exclusion of direct sunlight from the masses of cloud under observation, and the curve seems to indicate that up to the point where this occurred brightness increased rapidly as the mist gathered. Observations by Basquin⁴ and others upon the illumination received from the sky under different conditions are quite in accord with the indications given in this curve. The brightest sky corresponds to a cloudy rather than a clear condition of the heavens, but after a certain density of the cloud masses has been at-

tained the illumination falls off in consequence of the exclusion of direct sunlight from the visible surfaces of the clouds.

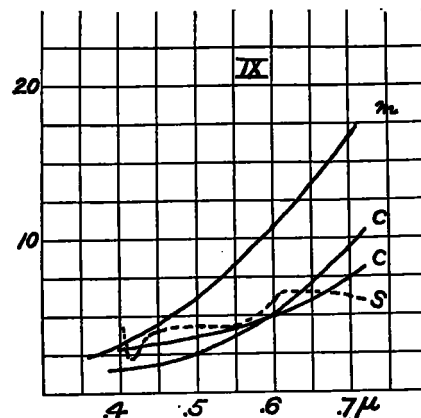


FIG. 9.

In the beginning of this paper I spoke of the curves obtained from overcast skies as being of a simple character, by which is meant that there is less evidence of selective reflection than is the case from the open sky. The distribution of intensities is such as to indicate a composition of light closely related to that of radiation from the carbon in the comparison flame, altho of course of very much higher temperature. Nearly all measurements of light from unclouded skies, particularly at times when the surface of the earth as well as the upper air are in sunlight, show on the other hand more or less well defined selectivity. A comparison of such curves with a curve for light from the sky taken upon a clear morning before sunrise—what I have called the *typical dawn curve* in the first of my previous papers already cited—shows a more or less complicated relationship like that represented in the curve *s* in fig. 9. I have discussed the nature of these ratio curves in the paper in question. When, however, we plot similar curves for the ratios of overcast or mist-filled skies to the typical dawn curve, in cases where the fog is of sufficient density to prevent the direct illumination of the surface of the ground, we get curves of the form *c* and *m* in fig. 9, which are quite free from the irregularities presented by the curve *s*. This would seem to indicate that the selectivity of ordinary skylight is due on the one hand to light reflected from the surface of the ground to the atmosphere, and on the other to selective reflection which takes place in the upper layers of the atmosphere and which is cut out by the intervention of a layer of mist or cloud so that the light from overcast skies is more directly related to sunlight, altho modified as to the distribution of intensities, than is the light commonly observed in the case of unclouded skies.

RAIN WITH LOW TEMPERATURE.

By A. LAWRENCE ROTCH. Dated Blue Hill Meteorological Observatory, January 18, 1909
[Reprinted at author's request from Boston Transcript of January 20, 1909.]

Many persons have been puzzled by observing, in the last two storms, the snow turn to rain while the temperature remained considerably below the freezing point.

The explanation is furnished by the data from kite flights which were made last week at Blue Hill in cooperation with the international series of ascensions of kites and balloons. Kites, carrying recording instruments, were flown on alternate days and entered a warm stratum, whose elevation varied from about 800 feet on the 11th to 3,500 feet on the 15th. Ordinarily, the temperature of these heights is from 3° to 10° lower than at the earth's surface, but during the past week it was actually some 10° warmer than below. Consequently, as

⁴ Basquin, *Illuminating Engineer* (N. Y.), Vol. I, p. 829.

the storm center approached and caused a general warming-up of the air column, altho the temperature at the ground might not exceed 25°, yet in the cloud at the same time it would be 35°, giving precipitation in the form of rain.

While these inversions of temperature, as they are called, commonly occur at some height in the atmosphere, yet it is rare that an inversion of such magnitude persists so long as did the one last week. On the afternoon of the 15th the approaching cold wave was pushing in beneath the warm stratum, since the cold does not descend from the upper regions as was formerly supposed.

GREAT INVERSIONS OF TEMPERATURE.

By Prof. A. J. HENRY. Dated Mount Weather, Va., January 28, 1909.

Great inversions of temperature at Mount Weather are more frequently found in the rear than in front of cyclones and therefore are not attended by precipitation.

From the 1st to the 20th of the month of January, 1909, an inversion of temperature at one altitude or another was recorded on every day that a flight was made. On the 15th, the day mentioned by Professor Rotch in the note above printed, three inversions were recorded at Mount Weather, as follows:

At the ground (526 meters), 7.2°C.; at 690 meters, 9.8°C.; difference, +2.6° C. in 164 meters.

At 1,906 meters, 2.3°C.; at 2,109 meters, 5.7° C.; difference, +3.4°C. in 203 meters.

At 2,972 meters, 0.1°C.; at 3,031¹ meters, 0.8°C.; difference, +0.7°C. in 59 meters.

The first of these inversions was due to ground fog, the upper limit of which had risen to 1,145 meters with a temperature of 8.3°C., when the kite descended later in the day. The second inversion was due to the passage of the kites thru a cloud layer. The cause of the third inversion is not known.

Cases have arisen in which the forecaster, by reason of a knowledge of upper air temperatures, has been able to make a prediction of rain (or snow as the case may be), when the surface conditions pointed to the opposite conclusion.

A very striking inversion of temperature occurred on January 9, 1909, when all the conditions were favorable for precipitation; only a little, however, occurred. I quote the observations in full, humidity being lacking.

KITE OBSERVATIONS JANUARY 9, 1909.

	Temperature at the kite.		Wind direction at the kite.
	°C.	°F.	
At the ground (526 meters)....	-7.2	19.0	southeast.
At 750 meters	-6.3	20.7	south.
At 1,009 meters	-4.6	23.7	south-southwest.
At 1,250 meters	+1.4	34.5	south-southwest.
At 1,500 meters	6.9	44.4	south-southwest.
At 1,750 meters	9.0	48.2	south-southwest.
At 2,000 meters	7.6	45.7	south-southwest.
At 2,250 meters	5.5	41.9	south-southwest.
At 2,500 meters	3.4	38.1	south-southwest.
At 2,750 meters	1.3	34.3	southwest.

These figures show that the cold surface air extended about 500 meters above the surface and that there was a warm stratum of air moving from the south-southwest over it. The depth of this warm layer was approximately 1,750 meters (5,741 feet). Its under surface where it glided over the cold surface air was only a few degrees warmer than the next underlying stratum of air, but at its middle portion the temperature was 16.2° C. (29.2° F.), higher than at the surface of the ground. The sky was cloudy when the kites were launched, the lower level of clouds being about 900 meters above the station. At 9:15 a. m. a few snow flurries were observed as also at 12:30 p. m. after the kites had been landed.

Evidently the snow was the result of cooling by mixture along the rather indefinite boundary between the two layers

of air. The upper warm current flowed in a direction parallel to the general trend of the Blue Ridge Mountains and consequently since the general level of the range changes but little, there was no opportunity for cooling by adiabatic expansion as would be the case in a current flowing at right angles to a mountain range. The air of the surface layer was saturated with moisture while that of the warmer air was doubtless considerably drier and hence it was possible for the surface fog and cloud to evaporate as actually happened later in the day.

The morning weather map gives a rather illuminating view of the weather conditions that prevailed at the time of the flight. An area of high pressure with its crest over New England, 30.50 inches, was passing to the eastward over the Atlantic. A dense layer of cloud overspread practically the whole country including the Atlantic coast, altho pressure in the last-named district exceeded 30.40 inches. At Asheville, N. C., light snow was falling with a southeast wind, thus showing that the conditions which existed at Mount Weather were common along the eastern slope of the Appalachians.

The kite flights at Mount Weather have repeatedly shown that the surface winds in areas of high pressure passing off to sea over the Atlantic coast are very shallow, and that at a few hundred meters above the mountain top warmer westerly winds prevail. On the border between the two wind systems there is always a rather thin cloud layer which under favorable conditions may increase in depth and produce rain.

But on the map in question the particular point to which I wish to draw attention is the rise of 20° F. in the surface temperature in Oklahoma, and also in the lower Lake region, while at Mount Weather a layer of warm air, relatively to the surface, prevailed at an altitude of about 500 meters above the station. It is the experience at Mount Weather that horizontally moving air currents having a temperature relatively higher than that of the surface descend rather slowly; thus a warm current, which first appears on the mountain top, has been known to require about twenty hours in the descent into the adjacent valleys, as shown at Trapp, 309 meters lower on the Loudoun side, and at Audley (near Berryville) on the Shenandoah side. It is assumed, therefore, that the surface warming shown on the weather map some distance from Mount Weather is evidence of the descent, during the previous twenty-four hours, of the layer of warm upper air which was observed at Mount Weather on the day in question. As a matter of fact the warm layer reached the surface at Mount Weather in about twenty-four hours after the kite observation.

A PORTABLE ROTATION PSYCHROMETER.

By P. J. O'GARA, Assistant, Bureau of Plant Industry. Dated New Castle, Cal., January 16, 1909.

A form of psychrometer, designed to take the place of the ordinary sling psychrometer where it is impossible to use the latter, such as in thickets or heavily-wooded areas, or in caves where humidity readings are desired, is shown in fig. 1. The instrument consists of a large bevel gear, provided with a crank which drives a small gear. The axis, around which the small gear turns, carries a light steel frame which is revolved by the small gear and to which the wet- and dry-bulb thermometers are attached. This steel frame is so formed as to protect the thermometers, and being constructed of steel bands which are channeled it is sufficiently stiff to resist bending, making it almost impossible to break the thermometers. In the instrument shown in fig. 1 the ratio of the large gear to that of the small one is such that a linear velocity of 25 feet or more per second may be given to the thermometer bulbs, thus providing the means for rapid evaporation from the wet-bulb thermometer. This form of psychrometer is

¹ This was at the highest point attained by the kite in this ascent.